47. (New) The computer readable media containing program instructions that, when executed, exercise code for minimizing noise in an integrated circuit according to claim 4, wherein the determination of the total path length of conductive paths coupled to a driver within said net includes a plurality of intersecting conduction paths.

48. (New) The computer readable media containing program instructions that, when executed, exercise code for minimizing noise in an integrated circuit according to claim 47, wherein an insertion position of at least one buffer along the plurality of conduction paths is chosen to yield a most acceptable integrated circuit timing characteristic.

REMARKS

The Examiner is thanked for his careful review of this application. Claims 1-4 have been amended. Claims 5-48 have been added. Claims 1-48 are pending after entry of the present amendment. Amendments were made to the specification for clarification and to correct editorial errors.

Drawings

The Examiner requested that Figure 2 be labeled as "Prior Art." The Applicant is hereby submitting a corrected Figure 2 in red ink for the Examiner's approval. Although the curves are prior art, their use in relation to the claimed invention is new.

Rejections under 35 U.S.C. § 101

Claims 2 and 4 were rejected under 35 U.S.C. 101 as being directed to non-statutory subject matter. Claims 2 and 4 have been amended to clarify that the claimed embodiments of the present invention are comprised of a computer readable media containing program instructions that, when executed, exercise code for minimizing noise in an integrated circuit. In view of the foregoing, the Applicants respectfully request that the Examiner withdraw the Section 101 rejections.

Rejections under 35 U.S.C. § 102

Claims 1-2 were rejected under 35 U.S.C. 102(b) as being anticipated by Jones et al., and were further rejected under 35 U.S.C. 102(e) as being anticipated by Alpert et al. (6,117,182) and Dwyer et al. These rejections are respectfully traversed.

As now amended, Jones et al., Alpert et al. (6,117,182), and Dwyer et al. fail to teach each and every element of the claimed inventions. Jones et al., Alpert et al. (6,117,182), and Dwyer et al. nowhere teach the use of noise amplitude versus conduction path length curves pertaining to a given driver for determination of noise acceptability along the associated net. Further, Jones et al., Alpert et al. (6,117,182), and Dwyer et al. nowhere teach the use of noise amplitude versus conduction path length curves pertaining to a given driver for determination of an acceptable buffer placement location along a net in the process of reducing noise along the net to an acceptable level. These features are now incorporated into the independent claims of the invention defined herein. For at least these reasons, it is submitted that the claimed invention is patentable over the cited prior art of record. In view of the foregoing, the Applicants respectfully request that the Examiner withdraw the Section 102 rejections.

Rejections under 35 U.S.C. § 103

Claims 3-4 were rejected under 35 U.S.C. 103(a) as being unpatentable over Jones et al., Alpert et al. (6,117,182) and Dwyer et al. in view of Applicant's own admission. These rejections are respectfully traversed.

Jones et al. is directed toward the placement of library cells (including buffers) for circuit optimization with noise avoidance as one criteria for circuit optimization. Similarly, Alpert et al. (6,117,182) is directed toward the insertion of buffers into an integrated circuit to affect noise reduction. Dwyer et al. is directed toward determining an optimal location for a circuit (i.e., buffer) along a net between a driver and receiver. Neither Jones et al. nor Alpert et al. (6,117,182) teach or suggest either alone or in combination the use of noise amplitude versus conduction path length curves for a given driver when determining the noise acceptability along an associated net. Rather, Jones et al. and Alpert et al. (6,117,182) teach the use of detailed analysis to determine if noise levels along a net are acceptable. Neither Alpert et al. (6,117,182) nor Dwyer et al. teach or suggest the use of noise amplitude versus conduction path length curves for a given driver when determining an acceptable location for insertion of a buffer along a net. Rather, Alpert et al. (6,117,182) teaches the use of detailed circuit analysis for determining an optimum buffer insertion position relative to the receiver node of the net. Also in contrast to the claimed invention, Dwyer et al. teaches a method for determining an acceptable buffer insertion position based upon locating the inserted buffer as close as possible to the midpoint along the shortest distance between the driver and a receiver of the associated net.

The use of detailed circuit analysis techniques to identify nets that are adversely affected by noise and identify acceptable locations along the subject net where a buffer may be inserted to alleviate the adverse noise problem is a computationally intensive

process due to the complexity of modern integrated circuit design. The claimed invention presents a method by which noise amplitude versus conduction path length curves for a given driver of a net may be used to more efficiently determine the noise characteristics and acceptable buffer insertion solutions for the net.

The method of the claimed invention includes an element which considers the replacement of a weaker driver with a stronger driver to overcome the noise present along a given net. To more clearly define the Applicants' claimed invention, independent claims 3-4 are amended to clarify that the driver replacement element of the method follows the use of noise amplitude versus conduction path length curves for the driver as a way for determining whether or not the net is adversely affected by noise. Furthermore, the driver replacement element of the claimed invention, when used in combination with the noise amplitude versus conduction path length curves to identify an appropriate candidate replacement driver, is neither taught nor suggested by the combination of Jones et al., Alpert et al. (6,117,182), and Dwyer et al.

The use of noise amplitude versus conduction path length curves for the driver of a net as set forth in present invention represents a distinct departure from the methods presented in the cited art of record relied upon by the Examiner as a basis for the Section 103 rejections. To more clearly define the Applicants' invention, language was added to the independent claims to define the use of noise amplitude versus conduction path length curves for a given driver. In view of the foregoing, the Applicants respectfully request that the Examiner withdraw the Section 103 rejections.

The Applicants respectfully submit that all of the pending claims are in condition for allowance. A notice of allowance is respectfully requested. If the Examiner has any questions concerning the present amendment, the Examiner is kindly requested to contact the undersigned at (408) 749-6903. If any additional fees are due in connection with

filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No. SUNMP099). A duplicate copy of the transmittal is enclosed for this purpose.

Respectfully submitted,
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Docket No: SUNMP099
Sutera, et al.	Group Art Unit: 2123
Application No: 09/430,350	Examiner: Jones, H.
Filed: October 29, 1999	Date: May 14, 2002
For: METHOD FOR REDUCING NOISE IN INTEGRATED CIRCUIT LAYOUTS	

MARKED UP AMENDMENT

MARKED UP SPECIFICATION

For page 1, first paragraph:

--The present invention relates to noise problems in integrated circuits. More particularly, the present invention provides a method for inserting buffers into an integrated circuit layout during the place and route stage in order to reduce the overall noise introduced into conductive paths in a given design.--

For page 2, second paragraph:

--This manual process is extremely time-consuming and very tedious because [by] moving conductive paths or increasing drivers is likely to cause new noise problems. Those new noise problems must then be corrected, potentially causing yet a third set of noise problems. Thus, manually correcting a circuit layout in order to solve noise problems often requires considerable effort and several very time-consuming iterations.--

For page 4, third paragraph:

--When referring to FIG. 1 and FIG. 4, it should be considered that driver and receiver labels may be substituted for one another due to the fact that some receivers can actually be drivers, vice-versa. Referring to FIG. 1, layout 10 includes driver/receivers 12 and 14 coupled together using conductive path 16. Further included are driver/receivers 18 and 20, driver 22 and receiver 24. Driver/receiver 18 is coupled to driver/receiver 20 using conductive path segments 26 and 28. At the intersection of conductive path segments 26 and 28, a conductive path segment 30 is coupled thereto. Driver 22 and receiver 24 are coupled to conductive path segments 32 and 34 respectively. Conductive path segments 32 and 34 are further coupled to conductive path segment 30.--

For page 4, fourth paragraph:

--The present invention analyzes each net (i.e., conducting path between connected drivers/receivers) individually to determine whether a given net is likely to have more than an acceptable level of noise coupled to it from external sources. External sources are considered to be anything other than net components such as driver/receiver combinations or drivers or receivers individually.--

For page 4, fifth paragraph:

--Although the coupling capacitance between interconnects is a source of potential coupling noise problems, the symptom of the noise peak is demonstrated at the output of the receiving cell. Different CMOS cells have differing tolerance for coupling noise impinging on their inputs. The choice for the maximum allowable wire length for [noice] noise violations to be prevented is therefore not only [dependant] dependent on the strength of the victim and aggressor drivers, but also on the type of cell at the end of the victim interconnect.--

For page 5, third paragraph:

--FIG. 3 is a flowchart depicting a method of one embodiment of the present invention.--

For page 6, second paragraph:

--At block 52, using the [noisy] noise amplitude vs. distance (i.e., conductor path length) data which is known by those of ordinary skill in the art and the acceptable noise levels previously determined for that given circuit type, it is determined whether the net chosen at block 50 is likely to exceed the acceptable noise levels. That question is posed [a] at block 54, and if the chosen net is likely to exceed maximum acceptable noise levels, it is determined, at block 56, whether a larger driver is available in the driver library which would solve the problem. If so, the method proceeds at block 58 where a larger driver is chosen to replace the previously determined weaker driver, thus solving the noise problem for this net.--

For page 7, first paragraph:

--If, at step 56, a larger driver was not available, the method proceeds at block 70 where a buffer is placed at a location which would increase signal levels on the net. Locations where buffers (i.e., drivers) are placed may be thought to be locations where the previous net ends and a new net begins. Thus, a buffer is placed at a location which would cause the conductive path between the driver and the buffer to be shorter than would otherwise have occurred. Since the conductive path is shorter, there is less susceptibility to noise.--

For page 7, second paragraph:

--In order to properly place a buffer so as to minimize the noise in a given net, it is necessary to know the point at which acceptable noise level line 40 [and] in FIG. 2 crosses the curve for the given driver. Thus, if a driver is employed which is represented by curve 62, it is necessary to know where point 72 is located. Knowing where point 72 is located gives you the maximum length of conductive path allowed in order to achieve an acceptable noise level for that conductive path.--

For page 8, second paragraph:

--Referring to FIG. 1 and FIG. 4, the net which includes driver/receiver 12, driver/receiver 14, and conductive path 16 has not been duplicated because it was previously determined that this net resulted in acceptable noise levels. The remaining net includes driver/receiver 18 and receiver 24 from FIG. 1, new driver/receiver 80, and new driver 82.--

For page 9, first paragraph:

--Now assume that buffer 92 has been placed within conductive path 84 because it is necessary that signals from driver/receiver 80 arrive at receiver 24 as quickly as possible. Once buffer 92 has been placed, the new question becomes whether the total conductive path length between the output of buffer (i.e., driver) 92 and the input to receiver 24 meets the previously defined criteria for noise.--

For page 9, second paragraph:

--If the previously defined criteria for noise is not met by the remaining total conductive path length, it is again necessary, at block 96 of FIG. 3, to determine where to place another buffer. Now, the FIG. 2 curve to be used is that curve associated with buffer

92. A new maximum acceptable path length will be determined from that curve, and it may be necessary to add a second buffer such as buffer 96 in FIG. 4.--

MARKED UP CLAIMS

1. A method for minimizing noise in an integrated circuit comprising:

choosing a net to be analyzed;

determining [that] if the total path length of conductive paths coupled to a driver within said net exceed a maximum acceptable length for that given driver according to [the] a minimum acceptable noise [levels] level for that given net, as determined by examination of a curve associated with the driver; and

inserting at least one buffer within said net at a position which is within the maximum acceptable length for conductive paths coupled to said driver, when the total path length of conductive paths coupled to the driver exceeds a maximum acceptable length for the driver according to a minimum acceptable noise level for that given net, as determined by examination of the curve associated with the driver.

2. [A machine readable medium having machine instructions stored thereon, the machine readable instructions including a method for minimizing noise in an integrated circuit, the method comprising:]A computer readable media containing program instructions that, when executed, exercise code for minimizing noise in an integrated circuit, the computer readable media comprising:

program instructions for choosing a net to be analyzed;

program instructions for determining [that] if the total path length of conductive paths coupled to a driver within said net exceed a maximum acceptable length for that

given driver according to [the] a minimum acceptable noise [levels] level for that given net, as determined by examination of a curve associated with the driver; and

program instructions for inserting at least one buffer within said net at a position which is within the maximum acceptable length for conductive paths coupled to said driver, when the total path length of conductive paths coupled to the driver exceeds a maximum acceptable length for the driver according to a minimum acceptable noise level for that given net, as determined by examination of the curve associated with the driver.

[2]3. A method for minimizing noise in an integrated circuit comprising:

choosing a net to be analyzed;

determining [that] if the total path length of conductive paths coupled to a first driver within said net exceed a maximum acceptable length for said first driver according to [the] a minimum acceptable noise [levels] level for said net, as determined by examination of a curve associated with the driver;

determining [that] if a second driver exists which provides a stronger signal output [then] than said first driver and which also is available to replace said first driver;

replacing said first driver with said second driver;

determining, once said first driver is replaced, [that] if the total path length of conductive paths coupled to said second driver within said net exceed a maximum acceptable length for said second driver according to [the] a minimum acceptable noise [levels] level for said net, as determined by examination of a curve associated with the second driver; and

inserting at least one buffer within said net at a position which is within the maximum acceptable length for conductive paths coupled to said driver, when the total path length of conductive paths coupled to the driver exceeds a maximum acceptable

length for the driver according to a minimum acceptable noise level for that given net, as determined by examination of the curve associated with the driver.

4. [A machine readable medium having machine instructions stored thereon, the machine readable instructions including a method for minimizing noise in an integrated circuit, the method comprising:]A computer readable media containing program instructions that, when executed, exercise code for minimizing noise in an integrated circuit, the computer readable media comprising:

program instructions for choosing a net to be analyzed;

program instructions for determining [that] if the total path length of conductive paths coupled to a first driver within said net exceed a maximum acceptable length for said first driver according to [the] a minimum acceptable noise [levels] level for said net, as determined by examination of a curve associated with the second driver;

program instructions for determining [that] if a second driver exists which provides a stronger signal output [then] than said first driver and which also is available to replace said first driver;

program instructions for replacing said first driver with said second driver;

program instructions for determining, once said first driver is replaced, [that] if the total path length of conductive paths coupled to said second driver within said net exceed a maximum acceptable length for said second driver according to [the] a minimum acceptable noise [levels] level for said net, as determined by examination of a curve associated with the second driver; and

program instructions for inserting at least one buffer within said net at a position which is within the maximum acceptable length for conductive paths coupled to said driver, when the total path length of conductive paths coupled to the driver exceeds a

maximum acceptable length for the driver according to a minimum acceptable noise level for that given net, as determined by examination of the curve associated with the driver.